

JEECUP Group-A Physics Sample Paper – 23

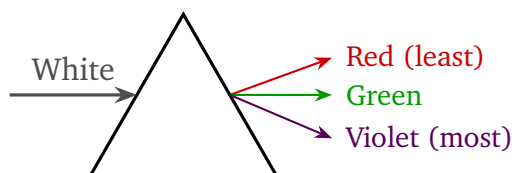
Duration: 45 Minutes

Maximum Marks: 100

Instructions

- This paper contains **25** Multiple Choice Questions (Single Correct).
- Each correct answer carries **+4 marks**. Incorrect and unattempted questions carry **0** marks.
- Only **one** option is correct for each question.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. When white light passes through a glass prism, it splits into its constituent colours (dispersion). The colour that deviates the most from its original path is:



- (A) Violet
- (B) Red
- (C) Green
- (D) Yellow

Q2. The sky appears blue during the day because:

- (A) The sun emits only blue light
- (B) Blue light is scattered most by air molecules (Rayleigh scattering)
- (C) The sky absorbs all colours except blue
- (D) Blue light travels fastest in air

Q3. Total internal reflection occurs when:



- (A) Light travels from rarer to denser medium at any angle
- (B) Light travels from denser to rarer medium at the critical angle
- (C) Light travels from denser to rarer medium at an angle greater than the critical angle
- (D) The refractive index of both media is equal

Q4. The linear magnification produced by a spherical mirror is given by:

- (A) $m = v + u$
- (B) $m = f/u$
- (C) $m = u/v$
- (D) $m = -v/u$

Q5. Among the colours of the visible spectrum, which colour has the highest frequency?

- (A) Violet
- (B) Red
- (C) Yellow
- (D) Green

Q6. Kirchhoff's Current Law (KCL) states that at any junction in an electrical circuit:

- (A) The sum of voltages is zero
- (B) The algebraic sum of all currents meeting at the junction is zero
- (C) All currents are equal
- (D) The current entering is always greater than the current leaving

Q7. A charge of 60 C flows through a conductor carrying a current of 3 A. The time taken for this charge to flow is:

- (A) 180 s



- (B) 57 s
- (C) 20 s
- (D) 0.05 s

Q8. An electric appliance rated 220 V, 2 A is used for 60 s. The electrical energy consumed is:

- (A) 440 J
- (B) 13200 J
- (C) 132 J
- (D) 26400 J

Q9. A fuse wire in a household electric circuit is made of a material with a:

- (A) Very high melting point and high resistance
- (B) Low melting point and suitable resistance so it melts if excess current flows
- (C) High conductivity and very low resistance
- (D) Low density and high strength

Q10. Which of the following correctly describes the effect of temperature on the resistance of a metallic conductor?

- (A) Resistance decreases as temperature increases
- (B) Resistance increases as temperature increases
- (C) Resistance is unaffected by temperature
- (D) Resistance first increases then decreases

Q11. A force F acts on a mass m to give acceleration a . If the force is doubled and the mass is halved, the new acceleration is:

- (A) $a/4$
- (B) $2a$

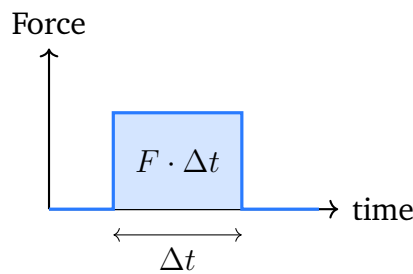


- (C) $4a$
- (D) a

Q12. In projectile motion (neglecting air resistance), which component of velocity remains constant throughout the flight?

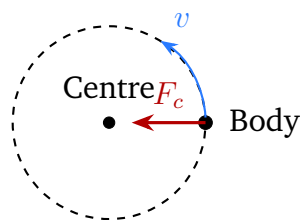
- (A) Vertical component
- (B) Both components change
- (C) Neither component changes
- (D) Horizontal component

Q13. The graph below shows a constant force F acting on a body for time Δt . The shaded area represents:



- (A) Impulse, equal to the change in momentum of the body
- (B) Work done by the force
- (C) Power of the force
- (D) Kinetic energy gained

Q14. A body moves in a uniform circular path. The centripetal force acting on it is directed:



- (A) Tangent to the circle



- (B) Away from the centre (outward)
- (C) Along the direction of velocity
- (D) Towards the centre (inward)

Q15. In a simple machine, if the load moved is 200 N and the effort applied is 50 N, the mechanical advantage is:

- (A) 0.25
- (B) 250
- (C) 4
- (D) 10000

Q16. For a simple pendulum, at which point of its swing is the kinetic energy maximum?

- (A) At the highest point on either side
- (B) At the same value throughout
- (C) When the string makes maximum angle
- (D) At the lowest (mean) position

Q17. The elastic potential energy stored in a spring compressed by a distance x (spring constant k) is:

- (A) $\frac{1}{2}kx^2$
- (B) kx
- (C) $2kx^2$
- (D) $\frac{kx}{2}$

Q18. In a calorimetry experiment, hot water at 80°C is mixed with cold water at 20°C . Which principle is used to find the final temperature?

- (A) Latent heat is released
- (B) Heat lost by hot water equals heat gained by cold water



- (C) Total temperature equals sum of both temperatures
- (D) Heat is always lost to the surroundings

Q19. In which mode of heat transfer does the actual movement of heated particles of the fluid carry heat from one place to another?

- (A) Conduction
- (B) Radiation
- (C) Convection
- (D) All of the above equally

Q20. A perfect black body is one that:

- (A) Reflects all incident radiation
- (B) Transmits all incident radiation
- (C) Absorbs no radiation
- (D) Absorbs all incident radiation and is the best radiator of heat

Q21. Resonance occurs in a vibrating system when the:

- (A) Frequency of the driving force equals the natural frequency of the system
- (B) Amplitude of vibration becomes zero
- (C) Driving frequency is much higher than the natural frequency
- (D) System is in vacuum

Q22. According to the Doppler effect, when a source of sound moves towards a stationary observer, the observed frequency:

- (A) Remains the same as the source frequency
- (B) Appears higher (pitch seems to increase)
- (C) Appears lower (pitch seems to decrease)
- (D) Becomes zero



- Q23.** Which of the three types of radioactive emissions (α , β , γ) has the highest penetrating power?
- (A) Alpha particles
 - (B) Beta particles
 - (C) Gamma rays
 - (D) All have equal penetrating power
- Q24.** The source of the Sun's energy is:
- (A) Burning of coal and hydrogen
 - (B) Nuclear fission of uranium
 - (C) Chemical reactions between gases
 - (D) Nuclear fusion of hydrogen nuclei into helium
- Q25.** Bernoulli's principle states that in a streamlined flow of a fluid, an increase in the speed of flow is accompanied by:
- (A) A decrease in pressure
 - (B) An increase in pressure
 - (C) No change in pressure
 - (D) An increase in temperature



Detailed Solutions

Q1.

Solution

Concept — Dispersion: Different colours of white light have different wavelengths and travel at slightly different speeds in glass, causing them to refract by different amounts.

Step 1: Violet light has the shortest wavelength in the visible spectrum and has the highest refractive index in glass, so it bends (deviates) the most. **Step 2:** Red light has the longest wavelength and lowest refractive index, so it deviates the least. The order is VIBGYOR (Violet–Indigo–Blue–Green–Yellow–Orange–Red) from most to least deviation.

Final Answer: Violet \Rightarrow (A)

Answer: (A) [Go Back to Q1](#)

Q2.

Solution

Concept — Rayleigh Scattering: Small particles (like air molecules) scatter shorter wavelengths more than longer ones. Scattering $\propto 1/\lambda^4$. **Step 1:** Blue light has a shorter wavelength than red, orange, or yellow. Air molecules scatter blue light much more strongly in all directions. **Step 2:** This scattered blue light reaches our eyes from all directions across the sky, making it appear blue. At sunset/sunrise, light travels through more atmosphere, scattering away all short wavelengths and leaving red/orange. **Final Answer:** Blue scattered most by Rayleigh scattering \Rightarrow (B)

Answer: (B) [Go Back to Q2](#)

Q3.

Solution

Concept — TIR Conditions: Two conditions must both be met: (1) light must travel from a denser medium to a rarer medium; (2) the angle of incidence must exceed the critical angle. **Step 1:** At angles less than the critical angle, refraction occurs (Option B). At exactly the critical angle, the refracted ray grazes the surface. **Step 2:** Beyond the critical angle, no refraction is possible — all light is reflected back (TIR). Applications: optical fibres, periscopes, binoculars. **Final Answer:** Denser to rarer at angle $>$ critical angle \Rightarrow (C)

Answer: (C) [Go Back to Q3](#)



Q4.

Solution

Concept — Mirror Magnification: $m = \frac{\text{Image height}}{\text{Object height}} = \frac{h_i}{h_o} = -\frac{v}{u}$. **Step 1:** Using $h_i/h_o = -v/u$ (derived from similar triangles in the ray diagram with the mirror formula). **Step 2:** If $m < 0$: inverted image (real). If $m > 0$: erect image (virtual). If $|m| > 1$: magnified; $|m| < 1$: diminished. **Final Answer:** $m = -v/u \Rightarrow (D)$

Answer: (D) [Go Back to Q4](#)

Q5.

Solution

Concept — Frequency and Colour: The frequency of visible light increases from red to violet: red ($\approx 4.3 \times 10^{14}$ Hz) to violet ($\approx 7.5 \times 10^{14}$ Hz). **Step 1:** Since $c = f\lambda$, higher frequency means shorter wavelength. Violet has $\lambda \approx 400$ nm; red has $\lambda \approx 700$ nm. **Step 2:** The order from highest to lowest frequency: Violet, Indigo, Blue, Green, Yellow, Orange, Red (VIBGYOR reversed). **Final Answer:** Violet has highest frequency $\Rightarrow (A)$

Answer: (A) [Go Back to Q5](#)

Q6.

Solution

Concept — Kirchhoff's Current Law (KCL): The algebraic sum of all currents at a junction = 0: $\sum I_{\text{in}} = \sum I_{\text{out}}$. **Step 1:** KCL is based on conservation of electric charge: charge cannot accumulate at a junction. **Step 2:** Kirchhoff's Voltage Law (KVL) — the other Kirchhoff's law — states that the algebraic sum of voltages around any closed loop = 0 (not currents). **Final Answer:** Sum of currents at junction = 0 $\Rightarrow (B)$

Answer: (B) [Go Back to Q6](#)

Q7.

Solution

Concept: $Q = It$, so $t = Q/I$. **Step 1:** $t = 60 \text{ C}/3 \text{ A} = 20 \text{ s}$. **Step 2:** Option A (180 s) uses $Q \times I$ instead of Q/I . **Final Answer:** $t = 20 \text{ s} \Rightarrow (C)$

Answer: (C) [Go Back to Q7](#)



Q8.

Solution

Concept: Electrical energy $E = VIt$ (or $E = Pt$). **Step 1:** $E = V \times I \times t = 220 \times 2 \times 60 = 26,400 \text{ J}$. **Step 2:** Option A (440 J) uses only $V \times I$; Option B (13200 J) uses half of 60 s.

Final Answer: $E = 26400 \text{ J} \Rightarrow (D)$

Answer: (D) [Go Back to Q8](#)

Q9.

Solution

Concept — Fuse Wire: A fuse is a safety device that melts and breaks the circuit when current exceeds the rated value. **Step 1:** The fuse wire is made of an alloy with a low melting point (e.g., tin-lead alloy, lead-tin). When excess current flows, the wire heats up rapidly and melts, breaking the circuit. **Step 2:** It must also have a suitable (not too low, not too high) resistance so it does not melt at normal current but melts quickly at overload current. **Final Answer:** Low melting point, suitable resistance $\Rightarrow (A)$

Answer: (A) [Go Back to Q9](#)

Q10.

Solution

Concept — Resistance vs Temperature: For metallic conductors, resistance increases with temperature because thermal vibration of lattice ions hinders electron flow. **Step 1:** $R = R_0(1 + \alpha T)$ where $\alpha > 0$ for metals (positive temperature coefficient). **Step 2:** For semiconductors (e.g., silicon, germanium), the opposite is true: resistance decreases with temperature (negative temperature coefficient). **Final Answer:** Resistance increases with temperature $\Rightarrow (B)$

Answer: (B) [Go Back to Q10](#)

Q11.

Solution

Concept: $a = F/m$. New values: $F' = 2F$, $m' = m/2$. **Step 1:** $a' = F'/m' = 2F/(m/2) = 4F/m = 4a$. **Step 2:** Doubling force doubles a ; halving mass doubles a again: net effect is $\times 4$. **Final Answer:** New acceleration $= 4a \Rightarrow (C)$

Answer: (C) [Go Back to Q11](#)



Q12.

Solution

Concept — Projectile Motion: Horizontal and vertical motions are independent. Gravity acts only vertically. **Step 1:** No horizontal force acts (air resistance neglected), so $a_x = 0$ and horizontal velocity $v_x = u \cos \theta = \text{const.}$ **Step 2:** Vertical velocity v_y changes continuously due to gravity ($a_y = -g$). The path is parabolic. **Final Answer:** Horizontal component stays constant \Rightarrow (D)

Answer: (D)

[Go Back to Q12](#)

Q13.

Solution

Concept — Impulse: Impulse $J = F \cdot \Delta t = \text{area under the Force-time graph} = \text{change in momentum } \Delta p$. **Step 1:** $J = F \cdot \Delta t = \Delta p = mv - mu$. The shaded rectangular area in the graph equals $F \times \Delta t$. **Step 2:** This shows Newton's Second Law in impulse form: a large force applied for a short time can produce the same change in momentum as a small force applied for a long time. **Final Answer:** Impulse = change in momentum \Rightarrow (A)

Answer: (A)

[Go Back to Q13](#)

Q14.

Solution

Concept — Centripetal Force: For circular motion, acceleration (and hence net force) is directed toward the centre of the circle. This is the centripetal force. **Step 1:** $F_c = mv^2/r$, directed radially inward (toward centre). It continuously changes the direction of velocity without changing its magnitude. **Step 2:** The velocity vector is always tangential (perpendicular to radius). The centripetal force is perpendicular to velocity, so it does no work ($W = F \cos 90^\circ \cdot d = 0$). **Final Answer:** Toward the centre \Rightarrow (B)

Answer: (B)

[Go Back to Q14](#)

Q15.

Solution

Concept: Mechanical Advantage = Load/Effort. **Step 1:** $MA = 200\text{ N}/50\text{ N} = 4$. **Step**

2: $MA > 1$ means the machine multiplies force (load > effort). Here, a 50 N effort lifts a 200 N load. **Final Answer:** $MA = 4 \Rightarrow (C)$

Answer: (C)

[Go Back to Q15](#)

Q16.

Solution

Concept — Pendulum Energy: Total mechanical energy is conserved. At the lowest point, height = 0, so $PE = 0$ and all energy is kinetic (KE is maximum). At the highest points, all energy is potential. **Step 1:** Lowest point: $h = 0$, $PE = 0$, $KE = \text{max}$ (= total energy). **Step 2:** Highest points: $v = 0$, $KE = 0$, $PE = mgh = \text{max}$. **Final Answer:** KE maximum at lowest (mean) position $\Rightarrow (D)$

Answer: (D)

[Go Back to Q16](#)

Q17.

Solution

Concept — Spring Potential Energy: $E_p = \frac{1}{2}kx^2$ (derived by integrating Hooke's law $F = kx$ over displacement x). **Step 1:** $E_p = \int_0^x kx' dx' = k[x'^2/2]_0^x = \frac{1}{2}kx^2$. **Step 2:**

Option B (kx) is the force, not energy. Option C ($2kx^2$) is twice the correct value. **Final Answer:** $E_p = \frac{1}{2}kx^2 \Rightarrow (A)$

Answer: (A)

[Go Back to Q17](#)

Q18.

Solution

Concept — Calorimetry (Method of Mixtures): When two bodies at different temperatures are mixed, heat flows from hot to cold until thermal equilibrium. Heat lost by hot = heat gained by cold. **Step 1:** $m_1c_1(T_1 - T_f) = m_2c_2(T_f - T_2)$, where T_f is the final temperature. **Step 2:** This is an application of conservation of energy (no heat lost to surroundings assumed). In reality, some heat escapes to the environment; a good calorimeter minimises this. **Final Answer:** Heat lost = heat gained $\Rightarrow (B)$

Answer: (B)

[Go Back to Q18](#)



Q19.

Solution

Concept — Convection: Unlike conduction (heat passes through stationary matter) and radiation (electromagnetic waves), convection requires the bulk movement of the fluid itself. **Step 1:** When a fluid is heated, it becomes less dense and rises; cooler, denser fluid sinks, creating convection currents. **Step 2:** Examples: sea breeze, land breeze, boiling water, atmospheric circulation. **Final Answer:** Convection \Rightarrow (C)

Answer: (C)[Go Back to Q19](#)

Q20.

Solution

Concept — Black Body: A perfect black body absorbs 100% of all electromagnetic radiation falling on it. It is also the best emitter of radiation at any given temperature. **Step 1:** Absorptivity = 1 (absorbs all). Emissivity = 1 (emits maximum for that temperature). Stefan-Boltzmann law: $P = \sigma T^4$. **Step 2:** A black body is black because it reflects no light. Example: a cavity with a small hole (blackbody cavity). **Final Answer:** Absorbs all incident radiation; best radiator \Rightarrow (D)

Answer: (D)[Go Back to Q20](#)

Q21.

Solution

Concept — Resonance: When the frequency of an external periodic force matches the natural frequency of a vibrating system, the system absorbs maximum energy and vibrates with maximum amplitude. This is resonance. **Step 1:** Example: a tuning fork of 256 Hz causes another tuning fork of 256 Hz to vibrate (sympathetic vibration). Soldiers break step on bridges to avoid resonance. **Step 2:** Resonance can be destructive (Tacoma Narrows bridge collapse) or useful (MRI, radio tuning). **Final Answer:** Driving frequency = natural frequency \Rightarrow (A)

Answer: (A)[Go Back to Q21](#)

Q22.

Solution

Concept — Doppler Effect: The apparent change in frequency of sound when source and observer move relative to each other. **Step 1:** Source approaching: successive wavefronts are compressed, so the observer receives more waves per second \rightarrow higher apparent frequency (higher pitch). **Step 2:** Source receding: wavefronts are stretched \rightarrow lower apparent frequency. Example: ambulance siren changes pitch as it passes. **Final Answer:** Apparent frequency increases (pitch rises) \Rightarrow (B)

Answer: (B) [Go Back to Q22](#)

Q23.

Solution

Concept — Penetrating Power: $\alpha < \beta < \gamma$ in penetrating power. **Step 1:** α : stopped by a sheet of paper or ~ 5 cm of air. β : stopped by a few mm of aluminium. γ : requires several cm of lead or metres of concrete. **Step 2:** Ionising power is the reverse: α (highest) $> \beta > \gamma$ (lowest). **Final Answer:** Gamma rays have the highest penetrating power \Rightarrow (C)

Answer: (C) [Go Back to Q23](#)

Q24.

Solution

Concept — Solar Energy: The Sun generates energy by nuclear fusion in its core. **Step 1:** Four hydrogen nuclei (${}^1_1\text{H}$) fuse to form one helium-4 nucleus (${}^4_2\text{He}$), releasing ~ 26 MeV per reaction (mass converted to energy via $E = mc^2$). **Step 2:** The Sun converts $\sim 4 \times 10^9$ kg of mass to energy every second. Nuclear fission (splitting, Option B) is used in nuclear reactors, not the Sun. **Final Answer:** Nuclear fusion of hydrogen nuclei \Rightarrow (D)

Answer: (D) [Go Back to Q24](#)



Q25.

Solution

Concept — Bernoulli's Principle: In streamline flow of an ideal fluid, the sum of pressure energy, kinetic energy, and potential energy per unit volume is constant: $P + \frac{1}{2}\rho v^2 + \rho gh = \text{const.}$ **Step 1:** If speed v increases, pressure P must decrease (to keep the sum constant). **Step 2:** Applications: aerofoil lift, Bunsen burner, carburettor, spray bottle, cricket ball swing. **Final Answer:** Pressure decreases when speed increases \Rightarrow (A)

Answer: (A)[Go Back to Q25](#)

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	B	3	C	4	D	5	A
6	B	7	C	8	D	9	A	10	B
11	C	12	D	13	A	14	B	15	C
16	D	17	A	18	B	19	C	20	D
21	A	22	B	23	C	24	D	25	A

